FACTORS ASSOCIATED WITH MATERNAL OBESITY AND ITS OUTCOMES AMONG PREGNANT WOMEN IN KLANG VALLEY A REVIEW FROM NATIONAL OBSTETRIC REGISTRY 2015

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By

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LIST OF ABBREVIATIONS

ACOG	American College of Obstetricians and Gynecologists
BMI	Body Mass Index
CI	Confidence interval
GDM	Gestational diabetes mellitus
HREC	Human Research and Ethics Committee
ICD-10	International Statistical Classification of Disease and Related Health Problems 10th Revision
IQ	Intelligence quotient
IUGR	Intrauterine growth restriction
MOGTT	Modified oral glucose tolerance test
MOH	Ministry of Health
MREC	Medical Research Ethics Committee
NGO	Non-Governmental Organization
NICU	Neonatal Intensive Care Unit
NIDDM	Non-insulin dependent diabetes mellitus
NMRR	National Medical Research Registry
NOR	National Obstetric Registry
OHA	Oral hypoglycemic agent

PCOS	Polycystic Ovarian Syndrome
2 HPP	Two hours post prandial
WHO	World Health Organization
WOCBP	Women of childbearing potential

LIST OF SYMBOLS

>	More than
<	Less than
=	Equal to
≥	More than and equal to
≤	Less than and equal to
α	Alpha
β	Beta
%	Percentage
Δ	Precision / Delta

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ABSTRAK

FAKTOR – FAKTOR YANG MEMPENGARUHI OBESITI DI KALANGAN IBU MENGANDUNG DAN KESANNYA DI KALANGAN IBU- IBU MENGANDUNG DI LEMBAH KLANG KAJIAN DARIPADA REGISTRI OBSTETRIK KEBANGSAAN 2015

Latar Belakang Kenaikan peratus kejadian obesiti dalam kalangan ibu mengandung di seluruh dunia adalah suatu yang membimbangkan kesihatan awam. Obesiti dalam kalangan ibu mengandung boleh memberikan kesan yang tidak baik kepada kesihatan ibu dan bayi.

Objektif Tujuan kajian ini adalah untuk menentukan peratusan, faktor – faktor yang menentukan kejadian obesiti dalam kalangan ibu mengandung dan kesannya di Lembah Klang pada tahun 2015.

Metodologi Satu kajian keratan rentas telah dijalankan pada Januari 2018 hingga Mac 2018 dengan menggunakan data sekunder yang diperolehi daripada Registri Obstetrik Kebangsaan. Semua ibu mengandung yang berdaftar dengan Registri Obstetrik Kebangsaan pada trimester pertama pada atau kurang dari 12 minggu yang memenuhi kriteria telah dimasukkan ke dalam kajian ini. Tiada kaedah persampelan digunakan. Semua maklumat data dikumpulkan dengan menggunakan proforma. Sejumlah 2113 ibu mengandung terlibat dalam kajian ini untuk menentukan peratusan indeks jisim badan mengikut WHO (1995) dan MOH (2003), namun kumpulan kurang berat badan tidak termasuk di dalam analisa yang berikutnya. Untuk

kesan negatif obesiti di kalangan ibu mengandung kepada ibu dan bayi, dua kumpulan iaitu indeks jisim badan normal dan obesiti yang merangkumi berat badan berlebihan dan obesiti digunakan.

Keputusan Mengikut jisim badan WHO (1995) , 149 (7.1%) mengalami kurang berat badan, 881 (41.7%) normal, 604 (28.6%) berlebihan berat badan, 336 (15.9%) obesiti kelas I, 98 (4.6%) obesiti kelas 2, dan 45 (2.1%) obesiti kelas 3. Namun, apabila jisim berat untuk Asia digunakan, terdapat kenaikan peratusan berlebihan berat badan sebanyak 2.7% dan obesiti kelas I sebanyak 12.8%. Kaum India (AOR 2.06, 95% CI: 1.11, 3.83, p = 0.021), Melayu (AOR 1.75, 95% CI: 1.02, 3.00, p=0.040), multipariti (AOR: 1.46, 95% CI: 1.23, 1.73, p<0.001) dan grandmultipariti (AOR 2.41, 95% CI: 1.78, 3.26, p < 0.001) didapati mempunyai hubungkait yang signifikan dengan kejadian obesiti di kalangan ibu mengandung. Terdapat hubungkait yang signifikan di antara obesiti di kalangan ibu mengandung dan kejadian darah tinggi semasa hamil (p=0.025), pembedahan secara caesarean (p =0.002) dan bayi makrosomia (p <0.001).

Rumusan Pengenalpastian faktor- faktor risiko membolehkan program pencegahan difokuskan kepada ibu hamil berisiko tinggi untuk mengurangkan risiko dan kesan tidak baik kepada ibu dan bayi.

KATA KUNCI: obesiti di kalangan ibu mengandung, Registri Obstetrik Kebangsaan, faktor hubungkait, kesan negatif ibu dan bayi

ABSTRACT

FACTORS ASSOCIATED WITH MATERNAL OBESITY AND ITS OUTCOMES AMONG PREGNANT WOMEN IN KLANG VALLEY

A REVIEW FROM NATIONAL OBSTETRIC REGISTRY 2015

Background The increasing prevalence of maternal obesity worldwide is a public health concern. It is well recognized that maternal obesity was associated with adverse fetal and maternal outcomes.

Objective This study aims to determine the proportion, associated factors and outcomes of maternal obesity among pregnant women in Klang Valley in 2015.

Methodology A cross sectional study was conducted between January to March 2018 using secondary data from National Obstetric Registry. All pregnant women with first trimester booking at 12 week and below, registered in National Obstetric Registry from Klang Valley in 2015 who fulfilled the inclusion and exclusion criteria were included in the study. No sampling method was applied. All information was collected using proforma. A total of 2113 were included in this study for determination of proportion according to WHO (1995) and MOH (2003) cut off points, however underweight was excluded for subsequent analyses. In maternal and fetal outcomes, respondents were classified into two groups which were normal and obese which comprised of overweight and obese and group.

Result According to WHO (1995) BMI cut offs points, 149 (7.1%) were underweight, 881 (41.7%) normal weight, 604 (28.6%) overweight, 336 (15.9%) obese class I, 98 (4.6%) obese class II, and 45 (2.1%) obese class III. However, when the Asian BMI cut off point was used, there was marked increased in the proportion of maternal overweight by 2.7% and obesity class 1 by 12.8%. Ethnicity which were Indian (AOR 2.06, 95% CI: 1.11, 3.83, p = 0.021) , and Malay (AOR 1.75, 95% CI : 1.02, 3.00 , p=0.040) and parity which were multiparity (AOR : 1.46, 95% CI: 1.23,1.73, p<0.001) and grandmultipara (AOR 2.41 , 95% CI :1.78, 3.26 , p < 0.001) were significantly associated with maternal obesity . There were significant association between maternal obesity with hypertensive disorder in pregnancy (p=0.025), caesarean section delivery (p=0.002) and macrosomic infant (p <0.001).

Conclusion Identification of risk factors among maternal obesity allow intervention programme to focus on high risk group women to lower the risk of adverse maternal and fetal outcomes.

KEY WORDS: maternal obesity, National Obstetric Registry, associated factors, adverse maternal fetal outcomes

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

1.1.1 Obesity trend among general population worldwide

Obesity has become a major and important public health problem in 21st century. The prevalence of obesity is growing at an alarming rate worldwide (Friedrich, 2017). This epidemic imposed a major challenge to non-communicable disease prevention across the life course all around the world (Bassett and Perl, 2004). Obesity is a complex, multifactorial disease that involved interaction between genetics, hormonal, behavioral, socioeconomic and environmental raises the risk of devastating morbidity and mortality (Chan and Woo, 2010). Therefore, many countries have seen the rise of obesity not only double, even quadruple over the last 30 years following the shift of economic growth, urbanization and industrialization (Agha and Agha, 2017).

Globally, obesity has nearly tripled since 1975. In 2016, more than 1.9 billion adults were overweight, and out of these, more than one third were obese (WHO, 2017). The rate is higher in women (Case and Menendez, 2009). Among children, the prevalence of overweight and obesity rose by 47.1% between years 1980 until 2013 (The *et al.*, 2014). Rate of obesity also showed increasing in both developed and developing countries (Bhurosy and Jeewon, 2014). In developed countries, the peak prevalence is moving towards younger generations (Ng *et al.*, 2014).

This worldwide phenomenon is happening in Malaysia as well. Generally, the prevalence of obesity in Malaysia for the past 10 years has showed increasing in trend by 4.4 % (26.2% in 2006 and 30.6% in 2015) (MOH, 2015). Furthermore, Malaysia has the highest prevalence of obesity in South East Asia. The prevalence of obesity among adult age 18 and above was 30.6%, with female (33.6%) higher than male (27.8%), and higher among married (33.8%) as compared to single women (22.7%). Indian ethnicity has the highest prevalence that accounts for 43.5%. In addition, the state with the highest prevalence of obesity was in Wilayah Persekutuan Putrajaya (43%) (MOH, 2015).

1.1.2 Obesity among women in reproductive age group and pregnant mother

As has been stated, the latest national population survey showed that the prevalence of obesity is higher among women (MOH, 2015). In addition, a study in Malaysia showed that the prevalence of obesity among women in reproductive age group (20-49) was 15.9% (Sidik and Rampal, 2009). The increase in the prevalence of obesity among women of child bearing potential (WOCBP) cause women to start their pregnancy with increased BMI. Therefore it leads to maternal obesity and this has important implications for the delivery of obstetric care (Bautista-Castaño *et al.*, 2013). The rise in global obesity rates will definitely show similar trend in pregnant mother.

There was a significant increase in the prevalence of maternal obesity worldwide. In United Kingdom there was significant increase in the proportion of obese women in early pregnancy over 15 years from 9.9% to 16.0% in 2004 with significant decrease in incidence of women with ideal BMI from 64.8 % in 1990 to 54.7% in 2004. The

regression analysis showed the rate of maternal obesity is accelerating over time (Heslehurst *et al.*, 2007a). Similarly, in India, the National Family Health Surveys shows an increase in prevalence of maternal obesity over seven years period from 10.6% to 14.8% in 2006 (Verma *et al.*, 2012). In Malaysia, the prevalence of maternal obesity was 14.6 % with highest prevalence among maternal with advanced age (45-49) account for 69.2%, and Malay ethnicity (16.8%), followed by Indian (15.6%) and Chinese (5.8%) (MOH, 2016). Apart from that, it was estimated that obesity accounted for 2.8% of a country's total healthcare expenditures (Withrow and Alter, 2011). Furthermore maternal obesity was also associated with greater length of hospital stay (Callaway *et al.*, 2006).

1.2 Problem Statement

Prevalence of obesity among women in reproductive age group is increasing worldwide including in Malaysia. Associated with increasing problems throughout the pregnancy, delivery complications with poor neonatal outcome, maternal obesity is a huge challenge to maternity services. It is well recognized that maternal obesity was associated with increased risk of maternal antenatal, intrapartum and postpartum complications such as hypertensive disorder in pregnancy, gestational diabetes mellitus and thromboembolic disorder (Bautista-Castaño *et al.*, 2013). Obesity is also associated with increased in caesarean section rate (Callaway *et al.*, 2006). Neonatal outcomes associated with maternal obesity include macrosomia, birth defects, prematurity, stillbirth and perinatal death (Vinturache *et al.*, 2015; Weiss *et al.*, 2004). In addition, as obesity is also associated with multiple adverse health conditions, thus this resulting in higher utilization of medical services and therefore cost consequence

is also prominent among obese populations (Musich et al., 2016). According to a study in UK, obese mother in early pregnancy was more likely to have higher number of antenatal care visits throughout the pregnancy. Obese mother had 39% increases in health service cost in addition to 30% higher mean number of days spent in hospital (Morgan *et al.*, 2014a).

However, despite the risk of being obese in pregnancy, the emphasis on the matter was lacking. The available national guideline on managing obesity (MOH, 2003) did not specifically highlight the implication of obesity to the reproductive age women. The importance of having specific approach on managing obese women in reproductive age group is because of many specific issues need to be addressed to this group, as they are having additional risk for being obese in childbearing age and they will face huge risk throughout the pregnancy once they conceive unprepared (Thornburg, 2011). Apart from that, with regards to the Malaysian Perinatal Care Manual third edition (2013), there is no such specific chapter and guideline on what and how to address the issues of obese pregnant women. In this manual, maternal obesity was considered as a risk factor and an indication for screening for antenatal complications such as gestational diabetes mellitus. It has not been addressed as a comorbid state, whereas it should has its own specific chapter on way of managing obesity in pregnancy during antenatal, intrapartum and postnatal period (Queensland Health, 2015). Furthermore, the pre- existing green tag coding that was indicated for pregnant women who are having weight pre pregnancy or at booking ≥ 80kg or increased in maternal weight more than 2 kg within one week is lacking. The risk stratification need to be revised as more literatures have shown the risk of maternal obesity was tremendous, and they need to be co-manage with the obstetricians,

anesthetists and other disciplines. Furthermore, more literatures showed pre pregnancy BMI or BMI at early booking should be considered for risk stratification rather than weight ≥ 80kg or gestational weight gain only (Buschur and Kim, 2012).

1.3 Study Rationale

To my best knowledge, published literatures on maternal obesity in Malaysia as regards to obesity in pregnancy and its outcome is still in infancy stage. In addition, there is no published study on maternal obesity by the National Obstetric Registry in Malaysia. Therefore, this research was conducted to determine the proportion, associated factors and the outcomes of obesity among pregnant women in Wilayah Persekutuan Kuala Lumpur and Selangor through the National Obstetric Registry database. Identification of the proportion and associated factors from the National Obstetric Registry, which is a national database, would provide insight for prevention plan to improve maternal health and pregnancy outcomes. The findings from this study also can be used as a baseline and guidance for the upcoming study in the same field, especially on gestational weight gain, pre-pregnancy BMI and intervention program to improve maternal and fetal health.

1.4 Research questions

1. What is the proportion of maternal obesity in Klang Valley 2015?
2. What are the factors associated with maternal obesity among pregnant women in Klang Valley?

3. What is the association between maternal obesity and maternal-foetal outcomes among pregnant women in Klang Valley?

1.5 Objectives

1.5.1 General objective

1. To study the proportion, associated factors and pregnancy outcomes in relation to maternal obesity in Klang Valley 2015?

1.5.2 Specific objectives

1. To determine the proportion of maternal obesity in Klang Valley 2015.
2. To determine the factors associated with maternal obesity among pregnant women in Klang Valley.
3. To identify the association between maternal obesity and adverse pregnancy outcomes in Klang Valley.

1.6 Research hypothesis

1. There are significant associations between socio- demographic factors with maternal obesity in Klang Valley.
2. There are significant association between maternal obesity and adverse pregnancy outcomes in Klang Valley.

CHAPTER TWO

LITERATURE REVIEW

2.1 Maternal and perinatal health

Maternal health refers to the health of women during pregnancy, childbirth and the postpartum period (WHO, 2018b). According to WHO (2016), globally, about 830 of womens' death was due to pregnancy or childbirth-related complications. It was estimated roughly 303 000 women died during and following pregnancy and childbirth in 2015, and mostly are preventable (WHO, 2016). The five major direct causes of maternal morbidity and mortality according to WHO which include hemorrhage, infection, high blood pressure, unsafe abortion, and obstructed labor. Among these, hemorrhage, high blood pressure, infection and obstructed labor were associated with maternal obesity (Anzaku *et al.*, 2015; Fyfe *et al.*, 2012; Roberts *et al.*, 2011; Vieira *et al.*, 2012).

Obesity in pregnancy has serious health consequence for both mother and infant, increases the complications throughout pregnancy and required more spaces on maternity unit resources. Maternal obesity is at risk for maternal deaths due to complications that arise during pregnancy and labor. According to Confidential Enquiry into Maternal Child Health (CEMAH) 2003-2005 report, more than half of maternal death were due to direct or indirect causes either overweight or obese, with more than 15% were morbidly obese (Bowyer, 2008).

Perinatal and maternal health are closely related. The ICD-10 defines "perinatal" as period that begins at 22 completed weeks (154 days) of gestation and ends seven completed days after birth. In 2009, 2.6 million stillbirths occur globally, more than 8200 deaths every day. Half of the stillbirth occurred in the intrapartum period, and out of 133 million babies born alive, 2.8 million die in the first seven days of life (WHO, 2018a). The patterns of these deaths are similar for maternal death. The three most common causes of neonatal death are infections (36%), preterm birth (28%), and birth asphyxia (23%) (WHO, 2011a). Among this, preterm birth and birth asphyxia were associated with maternal obesity (McDonald *et al.*, 2010; Persson *et al.*, 2014). The need of quality skilled care during antenatal and delivery are essentials for health of the mothers and their infant as maternal obesity was associated with higher risk for complication during antenatal, intrapartum and postpartum period that can lead to maternal and neonatal morbidity and mortality (Kuhnt and Vollmer, 2017).

2.2 Defining obesity in pregnancy

Obesity is defined as a condition with excessive accumulation of fat in adipose tissue that may cause impairment to the health (WHO, 2017). In general populations, one of the most commonly used indices of relative weight is the Body Mass Index (BMI). It was defined as body weight in kilogram divided by height, in meters squared. The WHO (2017) defined obesity as BMI $\geq$ 30kg/m^2. However for the Asian population, the risk imposed for the complications associated with obesity occurred at lower BMI cut offs points compared to Caucasian (WHO/IASO/IOTF, 2000). Few studies done

with regards to this matter for examples, in Hong Kong (Ko *et al.,* 2004) and in Singapore (Deurenberg-Yap *et al.*, 2000) showed there was an increasing prevalence of non-insulin dependent diabetes mellitus (NIDDM) and cardiovascular risk factors in parts of Asia, amongst below cut off points of less than 25kg/m^2 for overweight and less than 30kg/m^2 for obesity.

In obstetric populations, obese mother is defined as BMI equal or more than 30kg/m^2 (CMACE and RCOG, 2010), similar to the general populations. The NICE (2008) antenatal care guideline recommends that maternal height and weight should be measured for all pregnant women during initial stage of booking, preferably by 10 weeks of gestation, therefore BMI can be calculated. In area where lacking of availability of equipment, self-reported height and weight can be used (Heslehurst *et al.*, 2007b), however this may cause overestimation of height and underestimation of weight, especially in obese women, thus causing inaccuracy of risk assessment in pregnancy (Gorber *et al.*, 2007).

In view of BMI cuts offs points, a study in Singapore involving 8843 mothers showed the increasing prevalence of maternal obesity from 12.2 % (WHO cut-offs points) to 21.0% when Asian BMI risk categories was used (Ying Pang *et al.*, 2016). However, the prevalence of adverse feto-maternal outcomes associated with maternal obesity did not change with lower BMI cut off points.

2.3 Pre-existing chronic diseases in obese pregnancy.

Obesity is a well-recognized risk factor for both type 2 diabetes mellitus and hypertension, which are the leading causes of chronic kidney disease and end stage renal failure (Moghani Lankarani and Assari, 2017). Furthermore, obesity was associated with a spectrum of liver abnormalities, known as nonalcoholic fatty liver disease (NAFLD), characterized by an increased in intrahepatic triglyceride content or known as steatosis which subsequently can lead to inflammation (steatohepatitis) and fibrosis (Fabbrini *et al.*, 2010). Nonalcoholic fatty liver disease is more common among females and the prevalence of non-alcoholic steatohepatitis (NASH) is 10% in moderately obese patients and up to 20-50% of them will have elevated liver function test result.

Chronic hypertension occurs 1-5% in pregnancies and is associated with adverse pregnancy outcome. It was associated with superimposed preeclampsia, higher risk for caesarean section, preterm delivery, abruptio placenta, low birth weight, NICU admission as well as perinatal death (Bramham *et al.*, 2014). Chronic diabetes mellitus patient has significant risk for caesarean section, preterm birth and low birth weight baby. In addition, they have three to fourfold higher risk for congenital structural defects (Chen, 2005). In regards to nonalcoholic fatty liver disease in pregnancy, evidences suggested that women with this disease have two fold higher risks of gestational diabetes mellitus (De Souza *et al.*, 2016).

2.4 Health care services in Malaysia

Antenatal care services are provided both in primary care and hospital setting; co-managing patients between these facilities. The aim of the services is to improve pregnancy outcomes through a series of monitoring activities in the management plan. Risk approach system was implemented in Malaysia since 1989 by using four colour coding which are red, yellow, green and white that is based on patient's history and clinical examination. Red signifies life threatening condition that required urgent referral and admission to hospital, yellow indicates conditions requiring shared care between Family Medicine Specialist and Obstetrician, green implies care at the level of clinic by medical officers and nurse whereas white indicates absence of the defined risk factors (Yeoh et al., 2015). Furthermore, the Perinatal Care Manual was introduced in 2012 and revised in 2013 to help healthcare providers in managing all stages of pregnancies: pre- pregnancy care, antenatal care, intrapartum care, postnatal care and neonatal care. According to the Perinatal Care Manual (MOH, 2013), early booking is defined as booking done before 12 weeks and it is essential for early risk identification, intervention and treatment aiming to reduce maternal and perinatal morbidity and mortality.

2.5 National Obstetric Registry (NOR)

National Obstetric Registry (NOR) is a project initiated in 2007 at the Obstetrics and Gynecology congress. In September 2007 an initial meeting involving senior and Obstetrics and Gynecology consultants and clinical research center was held. The software was launch in May 2009 and on 1st July 2009 NOR existed online. The

national clinical research contributed in the development, implementation and administration of this registry. National Obstetric Registry compiles obstetric data to help healthcare in planning, implementation and evaluation in a population. There are fourteen tertiary and one district hospital across Peninsular Malaysia and East Malaysia that contributed to the data of National Obstetric Registry. This represent one third of obstetric practice in Malaysia. Each hospital has a dedicated Coordinator which comprises of an Obstetrics and Gynecology specialist and consultant and a nursing coordinator to monitor data entry into the registry. The National Obstetric Registry committee provides annual report from the data since 2009 with the latest report was on 2012. These reports provide an overview of obstetrics complications in Malaysia and the suggested recommendations. Apart from that there were publications by the committee such as effectiveness of selective risk based screening for Gestational Diabetes Mellitus (GDM) in Malaysia: A retrospective cohort study based on National Obstetric Registry of Malaysia (2017), Factors associated with recovery from 1 min Apgar score less than 4 in live singleton term births. An analysis of Malaysian National Obstetric Registry data 2010- 2012 (2017), BMI classifications based on specific public health action points as a predictor of adverse obstetric outcomes among Asians (2017). Apart from that, there were poster presentation such as Birth Weight and Relationship With Maternal BMI, Diabetes and Hypertension: A Quantile Regression Analysis of Term Births in the Malaysian National Obstetric Registry 2010 - 2012 (2017) , A 5 Year Review (2010- 2014) of Stillbirths From The National Obstetric Registry (2017) .

2.6 Factors associated with maternal obesity

2.6.1 Maternal obesity determinants

Maternal obesity is determined by several factors. Maternal factors including age, parity, and ethnicity, educational level, marital and smoking status may have an impact on maternal obesity (Callaway *et al.*, 2006; Gaillard *et al.*, 2013; Ying Pang *et al.*, 2016). Other than that genetics, access to nutritious foods, ability to be physically active and certain medical illness and medications did influence the prevalence of maternal obesity (Leddy *et al.*, 2008). Understanding these aspects as determinants to the risk of maternal obesity is crucial. It is important to identify pregnant women who are at risk so that effective interventions for optimal pregnancy outcomes can be done. Most importantly, maternal obesity is modifiable risk factors in pregnancy (Janjua *et al.*, 2012).

2.6.2 Socio- demographic and obstetric characteristics

Ying Pang *et al.* (2016) , Gaillard *et al.* (2013) and Callaway *et al.* (2006) reported older and multiparous women had higher risk of being obese. Similar findings were seen in a study by Heslehurst *et al.* (2007a), where advanced maternal age and multiparity were associated with maternal obesity after adjusting the confounders. However, this finding was different from study done by Boudet-Berquier *et al.* (2017) in which women aged 25- 29 were more likely to be obese compared to age 30-34 in primiparous women.

Studies had shown low maternal education level was associated with increased risk of obesity among pregnant women (Callaway *et al.*, 2006; Gaillard *et al.*, 2013) A

study among 54022 pregnancies in Flanders showed high pre pregnancy BMI was significantly more prevalent among women with lower levels of education (Bogaerts, 2014). A study of 36 821 women in UK showed that being in longer schooling period significantly reduced the odds from being obese in pregnancy (Heslehurst *et al.*, 2007a). Similar findings seen in a study by Boudet-Berquier *et al.* (2017) where pregnant women with higher level of education and professional worker were less likely to be obese.

A prospective cohort study in Rotterdam involving 6444 pregnant women showed that the highest prevalence of maternal obesity was among minority ethnic group Moroccan-origin women with OR 3.04 (95% CI: 2.47, 3.75) (Bahadoer *et al.*, 2015). Other study in Singapore, showed highest prevalence of maternal obesity seen among Malays (37.3%) followed by Indian (17.2%) and Chinese (4.6%) (Ying Pang *et al.*, 2016). A similar finding was found by Gaillard *et al.* (2013) in which maternal obesity was higher among non- European origin. In Australia, the risk of maternal obesity was higher among the aborigine and minority ethnic group (Callaway *et al.*, 2006). In contrast, study in Middleborough, UK involving 36 821 pregnant women showed ethnicity was not found to be associated with maternal obesity (Heslehurst *et al.*, 2007a).

Low socioeconomic status has been linked to maternal obesity. In Middleborough , UK a study of total 36 821 women over a 15 years period reported pregnant mother that live in deprived area (quintile 1-3) were two and half time more likely to be obese compared to those live in quintile 5 which was the least deprived area (Heslehurst *et al.*, 2007a). This finding was consistent with a study by Gaillard *et al.*

(2013) where low household income was associated with maternal obesity. Other factor that was associated with high BMI among pregnant women was cigarette smoking (Callaway *et al.*, 2006; Gaillard *et al.*, 2013). Apart from that, study in Middlesbrough, UK reported less maternal obesity was seen in women who were separated and widowers (Heslehurst *et al.*, 2007a). In contrast, study by Mkuu (2018) showed that women who were married or living together with partner had 73% higher risk of being overweight and obese. Other study showed no significant association between marital status and maternal obesity (McCall *et al.*, 2017).

2.7 Maternal and fetal outcome associated with maternal obesity

2.7.1 Maternal outcome of maternal obesity

Hypertensive disorder in pregnancy is increase with obesity. It comprises of gestational hypertension, preeclampsia-eclampsia, preeclampsia superimposed on chronic hypertension, and chronic hypertension (Mammaro *et al.*, 2009). Preeclampsia is a pregnancy specific disorder characterized by new onset hypertension and proteinuria. In developing countries up to 80% of maternal mortality was due to preeclampsia. There was consistently a positive association between maternal pre pregnancy BMI and the risk of preeclampsia revealed in most observational studies. According to Bodnar *et al.* (2005) the risk of preeclampsia rose strikingly as the BMI increases in trend; nearly tripled at the BMI 30kg/m^2. A prospective cohort studies of 1231 pregnant women showed that obese women had two and half times the risk of having hypertensive in pregnancy and 2.7 times the risk of preeclampsia among Latina women (Fortner *et al.*, 2009). A systematic review of thirteen cohort studies comprising of 1.4 million pregnant women showed

that the risk of preeclampsia will be doubled with every 7kg/m^2 increased in pre pregnancy BMI (O'Brien *et al.*, 2003). Other study by Sween *et al.* (2015) involving 373 women showed one percent increase in body fat was associated with approximately 12 % increase the odds of clinical preeclampsia.

Apart from that, gestational diabetes mellitus was also common among obese pregnant women. According to Ramonienė *et al.* (2017) in a study done in Lithuania involving 3247 women, obese women had three to eightfold higher the risk of GDM compared to normal BMI pregnant women. Similar trend was seen in a study done in Selangor, the odd ratio of having gestational diabetes mellitus was 2.45 times higher in obese mothers as compared normal BMI mothers (Logakodie *et al.*, 2017).

In terms of mode of delivery, maternal obesity had higher risk for caesarean section. According to a systemic review and meta-analysis of eleven published cohort studies showed that risk of delivery through caesarean section increased by 50% in overweight and doubled in obese women compared to normal BMI women (Poobalan *et al.*, 2009). In line with other studies, finding showed relative risk for emergency caesarean section was nearly doubled in morbidly obese women compared to normal BMI women (Hollowell *et al.*, 2014; Khashan and Kenny, 2009). In addition, obese mother was found to have reduced risk for instrumental delivery (Hollowell *et al.*, 2014). Usha Kiran *et al.* (2005) found obese mother did not appear to be at increased risk for assisted vaginal delivery, however they were 1.6 times higher the risk of caesarean section than spontaneous vaginal delivery. Furthermore, a study done in Australia reported instrumental delivery was associated with maternal obesity however, it was not significant after adjusting with other

confounders (Callaway *et al.*, 2006).

Obese mother had increased risk for postpartum hemorrhage after delivery. A study involving 3 913 women in Liverpool showed that obese women were at risk of developing postpartum hemorrhage after caesarean delivery. On the other hand, according to Fyfe *et al.* (2012) based on a study involving 11363 nulliparous singleton pregnancies in Auckland, there was an approximate twofold increased in risk for postpartum hemorrhage in obese women regardless mode of delivery.

2.7.2 Fetal outcomes of maternal obesity

Maternal obesity was associated with macrosomic baby. Many studies defined macrosomia as birth weight more than 4kg or birth weight above the 90^{th} percentile for weight (large for gestational age). A study involving 99 403 babies showed the risk of fetal macrosomia increased with increasing BMI. Morbidly obese women were at highest risk for having macrosomic baby with relative risk of 4.78 (95% CI: 3.86, 5.92) (Khashan and Kenny, 2009). A meta-analysis study involving 214 385 participants reported that maternal obesity was associated with excessive fetal growth with more than two fold the odds of delivering macrosomic baby (Gaudet *et al.*, 2014). Macrosomic baby was also associated with multiple complications such as risk of caesarean section, postpartum hemorrhage and shoulder dystocia (Robinson *et al.*, 2003). In addition, excessive growth fetus has been showed to have risk of developing infant and childhood obesity, thus predisposed to insulin resistance, diabetes and hypertension in adult life (Catalano, 2003).

Inconsistent findings were found in view of maternal obesity and the risk of shoulder dystocia. According to a case control study of 45 877 newborn, it showed that after adjusting the confounders, maternal obesity was not a significant independent risk factors for shoulder dystocia (Adjusted odd ratio 0.99, 95% CI: 0.5, 1.6). This study was found that fetal macrosomia was the most powerful predictor for shoulder dystocia with adjusted odd ratio 9.0 (95% CI: 6.5, 12.6) (Robinson *et al.*, 2003). In contrast, a meta-analysis study of 20 articles involving 2 153 898 participants by Zhang *et al.* (2018) showed that maternal obesity was associated with increased risk of shoulder dystocia with pooled relative risk between 1.29 to 2.47 in obese mother. Similar results found by Mazouni *et al.* (2006) where obese mother has three and half times the odds to have shoulder dystocia.

A study by Radulescu *et al.* (2013) found that 50% of intrauterine growth restriction (IUGR) was found in obese mother class III, 26.7% in obese class II and 14.4 % in obese class I. Many studies have shown IUGR was more common among obese mother with preexisting comorbid such as chronic hypertension, preeclampsia, pregestational diabetes mellitus and chronic kidney disease (Davidson *et al.*, 2015; Gutaj and Wender-Ozegowska, 2016; Srinivas *et al.*, 2009).

A systematic review and meta-analysis of 57 studies showed that maternal obesity was associated with increased risk of structural anomalies with the highest occurrence of spina bifida with the odds of 2.24 (95% CI: 1.86, 2.69) compared to normal BMI mother followed by cardiovascular anomalies, septal anomalies, cleft lip and palate, anorectal atresia, hydrocephalus and limb reduction anomalies (Stothard *et al.*, 2009). A similar finding was found in other study by Persson *et al.* (2017)

involving 1.2 million singletons reported that the risk of congenital malformation was progressively increased with increasing maternal BMI.

According to a systematic review and meta-analysis of 11 studies involving 2 586 265 participants, it shows that there was a significant trend for maternal BMI and low Apgar score at 5 minutes with odd ratio of 1.22, 1.34 and 1.66 in overweight, obese, and morbidly obese respectively. Similar findings in a study of 58 089 women reported the odd of having low Apgar score is increasing with higher maternal BMI (Chen *et al.*, 2010). Infants who were delivered with low Apgar score were at increased risk of poor cognitive function in later life (Odd *et al.*, 2009). A study showed infant with brief or prolong low Apgar score was more likely to have low IQ in non – encephalopathic infants (Odd *et al.*, 2008). In severe low Apgar score at 5 minutes was strongly associated with neonatal encephalopathy with subsequent cerebral palsy by 145 fold and neonatal death up to 642 folds compared to those delivered with higher Apgar score (Moster *et al.*, 2001).

Maternal obesity was associated with fetal death. A study by Yu *et al. (* 2006) showed that there was increased in perinatal mortality in obese group by 5.7 per 1000 in obese group versus 1.4 per 1000 in normal BMI group. Other study reported increasing BMI was associated with increasing rate of infant mortality from 2.4/1000 to 5.8/1000 in women with obesity class III (BMI ≥40.0) as compared to normal weight women (Johansson *et al.*, 2014). In addition, class III obesity was associated with more than doubled the risks of neonatal deaths due to birth asphyxia and other neonatal morbidities, while obesity class II-III was associated with increased risk of infant mortality due to congenital anomalies and sudden infant

death syndrome (Johansson *et al.*, 2014). Similar findings were found in other studies even after adjusting with other confounders such as smoking, hypertensive disorder and diabetes (Kristensen *et al.*, 2005; Salihu *et al.*, 2007).

2.8 Conceptual Framework

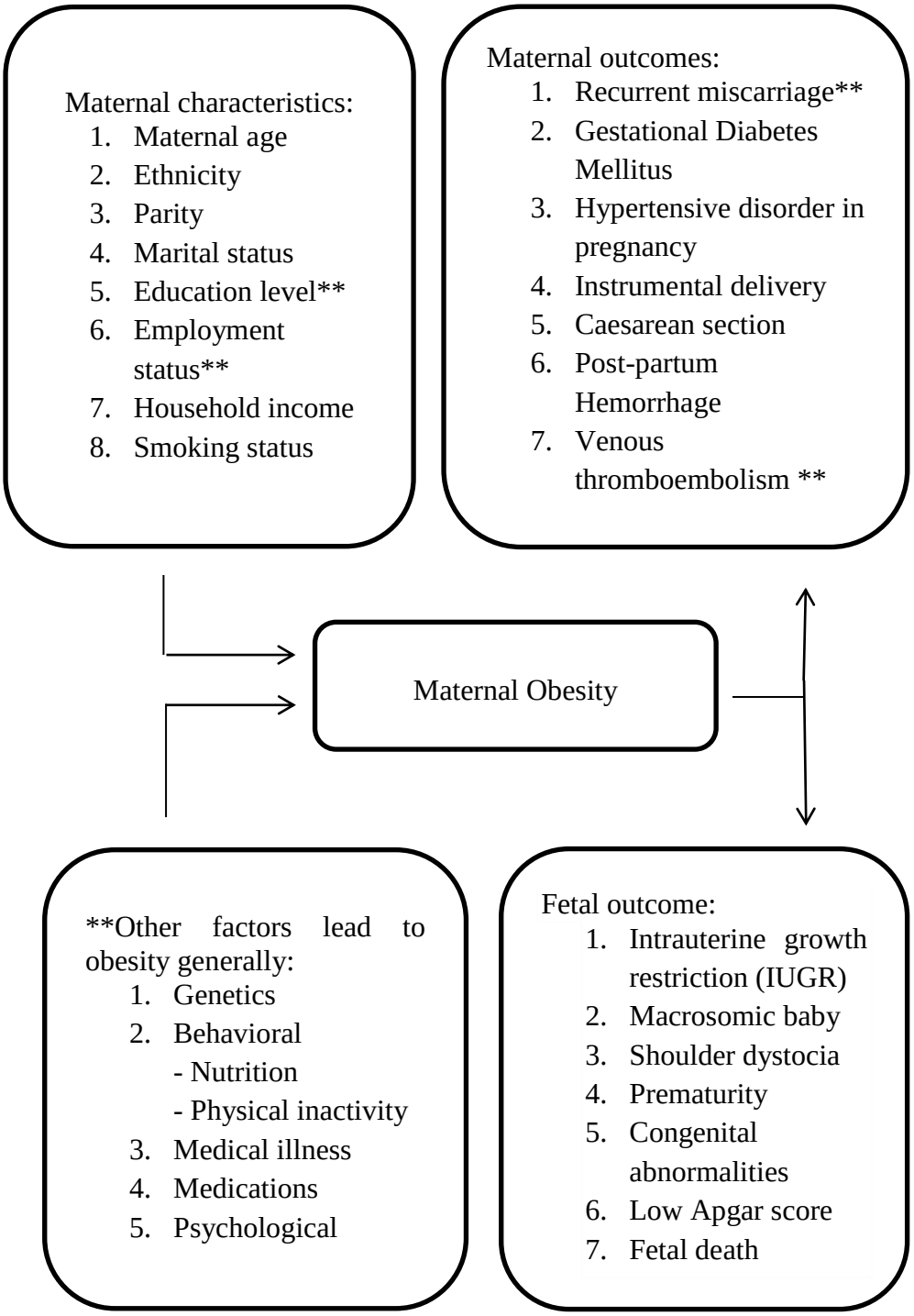
Based on Figure 2.1, there were several parameters involved in understanding the associated factors of maternal obesity such as:

i. Maternal characteristics which includes:
   a. Maternal age
   b. Ethnicity
   c. Parity
   d. Marital status
   e. Mother's education level
   f. Employment status
   g. Household income
   h. Smoking status

ii. Other factors :
   a. Genetics- Specific variant of a single gene (monogenic obesity)
   b. Behavioral - Physical inactivity and nutrition intake with high calories and fats contents.
   c. Medical illness – Endocrine disorders like hypothyroidism, Cushing's syndrome and Polycystic Ovarian Syndrome (PCOS).
   d. Medications – Corticosteroids, antiepileptic eg carbamazepine, valproate, oral hypoglycemia agent (OHA) , insulin, sulfonylurea.

e. Psychological

However, these factors (ii) were not studied as secondary data from National Obstetric Registry did not provide the data above. Apart from that, association between maternal obesity with maternal and fetal outcomes also were investigated.



** These factors were not covered in this study

Figure 2.1: Conceptual frameworks of maternal obesity and its outcome

CHAPTER THREE

METHODOLOGY

3.1 Study design

The study design is cross sectional study.

3.2 Study duration

This study was conducted from January 2018 to March 2018.

3.3 Study location

The study was conducted by using data derived from National Obstetric Registry involving tertiary centre in Klang Valley.

3.4 Reference population

All pregnant women in Klang Valley.

3.5 Source population

All pregnant women registered in the National Obstetric Registry from Klang Valley in 2015.

3.6 Sampling frame

All pregnant women who were registered in the National Obstetric Registry from Klang Valley in 2015 that fulfilled the inclusion and exclusion criteria.

3.7 Study criteria

3.7.1 Inclusion criteria

All pregnant women in Klang Valley registered in the National Obstetric Registry in 2015:

i. Delivered singleton newborn
ii. Booking done ≤ 12 weeks period of amenorrhea
iii. Cephalic presentation

3.7.2 Exclusion criteria

i. Incomplete data with absence of either weight or height or unrealistic value due to incorrect data entry
ii. Absence of gestational age during booking
iii. Pregnant women with pre-existing comorbidities such as :
    a) Diabetes mellitus type 1or type 2
    b) Chronic hypertension
    c) Chronic kidney disease